Boronieae, which display a wide range of nearly related forms of limited distribution ; (2) groups, as Xanthoxyleae-Evodiinae in eastern Australia, and Xanthoxyleae-Decatropidinae in Mexico and West Indies, which show a considerable number of widely separated forms or genera confined to limited areas ; (3) groups and genera possessing more or less numerous forms in widely separated localities ; (4) single groups and genera of few forms which occur in widely separated regions ; (5) certain isolated genera, as Spathelia, Chloroxylon, and Dictyoloma, whose derivation the author believes to have been from a stock distinct from that of the more widely distributed groups of Rutaceae. By means of color upon map outlines, three handsome plates, which accompany the text, graphically represent the distribution of particular genera, and by elucidating the text add greatly to the comfort of the reader.—J. G. C.

NOTES FOR STUDENTS.

THE ALMOST simultaneous announcement of the discovery of spermatozoids in *Ginkgo biloba*[12] and *Cycas revoluta*[13] is one of the most startling botanical announcements of recent years. The work of Ikeno upon *Cycas revoluta*, begun three years ago, attracted attention from his announcement of a distinct ventral canal cell,[14] the existence of which was in doubt. These various announcements, however, are very brief and are but preliminary to the full illustrated papers which will be awaited with great interest.

In the case of *Ginkgo biloba* Hirase has observed the following facts: The pollen grain consists of two prothallial cells and the tube cell, the latter developing a much branched tube, the branches of which spread out over the surface of the thin nucellus cap. The innermost of the two prothallial cells enlarges and divides to form the stalk and generative cells. The generative cell then divides and the two daughter cells form motile spermatozoids, instead of the customary non-motile male cells. The spermatozoids are egg shaped, $49 \times 82\mu$, and have a central nucleus completely surrounded by cytoplasm. The head consists of a three-coiled spiral with numerous cilia, and a pointed tail was also observed. Within the nucellus above the archegonia there is an abundant liquid, probably secreted by the archegonia, in which the spermatozoids were observed to swim about with a rotating motion.

In *Cycas revoluta* Ikeno obtained almost identical results. The spermatozoids are a little larger than those of Ginkgo and the head is a spiral with four turns bearing numerous cilia. The production in each pollen tube of

[12] S. Hirase (Tokyo) in *Botanical Magazine*, Oct. 1896, and in *Bot. Central.* Jan. 14, 1897.

[13] S. Ikeno (Tokyo) in *Botanical Magazine*, Nov. 1896, and in *Bot. Central.* Dec. 30, 1896.

[14] Bot. Central. 33: 193. 1896.

two spermatozoids by the division of the generative cell was also confirmed. Ikeno's work was entirely upon fixed material, so that he was unable to follow the motion of the living spermatozoids as Hirase had done, but he is sure that the spermatozoids reach the egg by swimming, as at the time of fertilization a large amount of water was observed between the cap cells of the nucellus and the necks of the archegonia.

This discovery of a close association of ginkgo and the cycads is but confirmatory of what has been long suspected, as the former is too exceptional among the conifers not to have attracted attention, and more than one morphologist has suggested that it was a small-leaved cycad, rather than an anomalous conifer. Such confirmation, however, while it would have been notable enough under ordinary circumstances, is far eclipsed in importance by the discovery of the association of siphonogamic and zoidiogamic fertilization. One of the most important barriers between pteridophytes and spermatophytes is thus broken down, and the transition to siphonogamic fertilization brought out with almost diagrammatic clearness. The further interesting fact is noted that in these two forms the pollen tube does not reach the archegonium, and hence motile spermatozoids are necessary. The general primitive character of these forms must be remembered, so that it need not be expected that such a condition of fertilization will be found extensively present among the gymnosperms.—J. M. C.

THE IMPORTANT OBSERVATIONS of Professor Harper on "The Development of the perithecium in *Sphærotheca Castagnei*"[15] have been supplemented and extended by his studies on the development of the perithecium of Erysiphe, which, together with further observations on Sphærotheca and on Ascobolus, form the subject of his more recent and very interesting paper, "Ueber das Verhalten der Kerne bei der Fruchtentwickelung einiger Ascomyceten."[16] After giving a brief summary of the literature relating to the sexuality of the ascomycetes, the writer reviews and extends his previously published account of the development of Sphærotheca, and then describes the corresponding phenomena observed in *Erysiphe communis*. In this genus, as in Sphærotheca, the perithecium originates from two branchlets, derived from different hyphæ, the one oogonial, the other antheridial. The tips of these branches become separated by septa to form each a terminal cell, the smaller (antheridium) applying itself closely to the larger (oogonium). As a result of the absorption of the intervening walls an open communication is then formed between these two cells through which the single nucleus of the antheridium makes its way into the oogonium, where it unites with the nucleus of the latter. The stalk cell which bears the oogonium then produces

[15] Berichte d. Deutsch. Bot. Gesell. **13**: 67. 1895.

[16] Prings. Jahrb. f. wiss. Bot. **29**: 655–685. 1896.

terminally a layer of branches which grow up around it, and presently between this layer and the oogonium or carpogonium at least one more layer is similarly produced, these layers by further growth and branching forming the resultant perithecial wall. The changes which take place in the oogonium differ in many respects from those which occur in Sphærotheca. The fusion nucleus divides repeatedly until there are from five to eight nuclei in the carpogonium, which has in the meantime become elongate and somewhat bent. Through the formation of transverse septa the latter organ then becomes converted into a series of superposed cells, each containing a single nucleus, except the penultimate, in which there are always more than one. This penultimate cell constitutes the ascogonium, which gives rise from all parts of its surface to ascogenic hyphæ. The ascogenic hyphæ then divide to two or three cells, and of these one, which is always intercalary, grows directly to form the ascus, five to eight of which eventually mature. The cells of the ascogenic hyphæ which are destined to form asci are distinguished by the fact that they contain two nuclei that ultimately unite to form a fusion nucleus which presently divides to form the ascospores.

The author, in addition to further interesting observations on Erysiphe that cannot here be mentioned, also gives an account of the development of Ascobolus; which, however, from the fact that no very early stages were observed, leaves the question as to the presence or absence of a sexual union in this instance still an open one. The formation of a fusion nucleus in the young ascus was determined, and interesting details are presented concerning the structure and nuclear characters of the carpogonium. The paper, which is clearly written and refreshingly concise, closes with a suggestive discussion and comparison of the phenomena above mentioned in connection with some of the more recent theories respecting the sexuality of the higher fungi, and it need only be noted here that the author is not inclined to admit the sexual nature of the nuclear fusions which immediately precede spore formation in so many cases among these plants.—R. T.

THE INTERRELATIONS of the different sciences is well illustrated in the advance that has been made in our knowledge of the action of chemical substances on living protoplasm from the physico-chemical standpoint. From this point of view, Paul and Krönig [17] have contributed an exceedingly valuable article on the effect of different chemicals upon plant life. The general trend of the paper follows the lines that have recently been developed by Kahlenberg and True,[18] although no reference is made to the pioneer work done by these American investigators who worked upon green plants.

As the bacterial spore is not affected by plasmolysis Paul and Krönig find

[17] Zeit. f. phys. Chemie 21 : 414. 1896.

[18] BOT. GAZ. 22 : 81. 1896.

these structures better adapted to their purpose than the vegetating cells. Exposure of the bacteria to the action of the desired chemical is made by immersing in a solution of definite strength small garnets of uniform size that have previously been coated with a film of an infected solution. After a definite exposure, these are removed and replaced in nutrient media. The intensity of chemical action is noted by the development of the cultures.

The explanations that have been offered to account for the action of different chemicals upon living matter have been far from satisfactory. The whole subject is in a chaotic state, and while we possess sufficient empirical knowledge to enable us to arrange chemical substances in order of their effectiveness, no underlying principle has yet been brought to light that coordinates the enormous mass of facts that have been collected within recent years. While in strong solutions it is undoubtedly true that the destructive effect of certain chemical substances is due to their corrosive or oxidizing properties, whereby the protoplasm is actually destroyed, there can no longer be any doubt, from the results here obtained, that in dilute solutions, the action of the molecule is largely dependent upon the dissociation that it undergoes in the solution. Paul and Krönig find by using solvents such as ether and absolute alcohol that do not permit dissociation of the salt into its constituent ions, that its toxic effect is slight; whereas if the salt is separated into the basic and acid ions, even in part, as in dilute watery solutions, its action is much more marked. In a number of instances where the disinfecting effect of a salt is diminished by the addition of other substances, as $HgCl_2$ in contact with NaCl, they find the explanation of these results in the formation of complex ions in which the actively disinfecting ion is not free to exert its toxic effect. Thus, while silver and gold salts, as $AgNO_3$ and $HAuCl_4$ are powerful germicides, their action is greatly weakened when mixed with KCy.

The remarkable observation made by Scheurlen[19] that the effect of phenol is increased by adding such a salt as NaCl, they are able to confirm, but, in the light of this theory, they are unable to explain it. The application of this new theory to the action of chemical substances on bacteria is most suggestive as it brings a large mass of isolated facts under the operation of a general law.— H. L. RUSSELL.

THE ORGANIC NUTRITION of green plants has just been considered by Th. Bokorny.[20] He suggests that the ability of fungi to use organic food is not to be considered peculiar to them. We know that many cells in a green plant are always nourished with organic substances. Only in the leaves and a small part of the stem is chlorophyll present and only in these parts can CO_2

[19] Die Bedeutung d. Molekularzustandes d. wassergelösten Desinfektionsmittel f. ihren Wirkungswert. Strassburg, 1895.

[20] Ueber die organische Ernährung grüner Pflanzen und ihre Bedeutung in der Natur. Biologisches Centralbl. 17: 1–20, 33–48. 1897.

be assimilated. All other cells of the plant must use as food such substances as sugar, asparagin and amides from which to construct cellulose, starch and protoplasm.

A large number of cultures were made to determine whether plants could use organic food. Weak solutions of various acids, alcohols, aldehydes, ketones and amido-compounds were employed. Since free acids are always poisonous they were neutralized with milk of lime. Except where the compounds employed were active poisons, almost none failed to be, to some extent, assimilated.

The author gives in condensed tabular form the results of his own work and that of other investigators. Some organic compounds can be used only in presence of light and assimilation is aided by light in all cases. Such substances as peptone, glycerin, asparagin and sugar in which fungi grow luxuriantly are also suitable as food for green plants.

Of great interest is the successful artificial culture of green plants with amido compounds such as asparagin, leucin, tyrosin, glycocol, etc., since these products of proteid decomposition are often present naturally in the soil. It has been definitely shown that asparagin can furnish nitrogen for the formation of proteids and in some cases plants thrive better if provided in this way than when obliged to obtain nitrogen from nitrates of the alkali metals.

The significance of the use by plants of organic matter is not to be underrated. Plants thrive better when furnished with such food. Decomposition products are taken up by plants and thus removed from the soil. Rivers, polluted with sewage, undergo, by means of the vegetation they contain, a continual self purification.

Many carbon compounds can be assimilated by green plants in the dark. A preliminary splitting of the molecule into CO_2 and H_2O does not occur, for the assimilation of CO_2 takes place only in the light. The author is inclined to agree with the hypothesis of O. Loew that from all organic substances used as food the molecular group CHOH is produced, and either with the aid of ammonia proteids are formed, or without such assistance carbohydrates are developed. In support of this theory he adduces the fact, proven by experiment, that such compounds as contain the group CHOH ready made are most readily assimilated. Further investigation on this point is very much needed.—FRANCIS RAMALEY, *University of Minnesota.*